

28. (Amended) The gate stack structure of claim 26 wherein said a gate stack includes ~~[an annealed] a crystalline metallic silicide film substantially devoid of silicon clusters.~~

REMARKS

The Office Action mailed September 23, 1999, has been received and reviewed. Claims 23 through 28 are currently pending in the application. Claims 23 through 28 stand rejected. Applicants have amended claims 23-25, and 27-28, and respectfully request reconsideration of the application as amended herein.

35 U.S.C. § 112 Rejections

Claim 25 stands rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as the invention. More specifically, claim 25 is rejected because the language "a sufficiently low temperature" is allegedly unclear.

Claim 25 has been amended and the language upon which the 35 U.S.C. § 112, second paragraph, rejection is based has been deleted. Applicants request that the rejection be withdrawn because no basis for a 35 U.S.C. § 112, second paragraph, rejection remains.

35 U.S.C. § 102(b) Anticipation Rejection

Anticipation Rejection Based on U.S. Patent No. 5,428,244 to Segawa et al.

Claims 23 through 28 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Segawa et al., U.S. Patent No. 5,428,244. Applicants respectfully traverse this rejection, as hereinafter set forth.

Applicants have deleted the terms "non-annealed" and "annealed" from claims 23-25, and 27-28, by the Amendments herein. Therefore, the Examiner's objection to the terms "non-annealed" and "annealed" as non-limiting has been resolved by the amendments to the claims.

A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference. *Verdegaal Brothers v.*

Union Oil Co. of California, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). The identical invention must be shown in as complete detail as is contained in the claim. *Richardson v. Suzuki Motor Co.*, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989).

Segawa et al. disclose a gate stack having a crystallized metallic silicide film which has been annealed. The process of creating the gate stack of Segawa et al. includes a heat treatment "carried out at 850° to 950° C" which causes "the crystallization of the [metallic silicide] film 4." *See, Segawa et al.*, col. 14, lines 1-3 (emphasis added). Therefore, Segawa et al. fails to disclose a non-crystalline metallic silicide film because the heat treatment step necessarily forms a crystalline metallic silicide film. This also forms silicon clusters within the metallic silicide film because "when a silicon rich metallic silicide is used, the annealing step causes the silicon within the metallic silicide to form clusters inside the crystalline structured metallic silicide film." *See, Specification*, page 5, lines 13-15.

Claims 23, 25, and 27 of the present invention each recite a gate stack having a "non-crystalline metallic silicide film" which is not described by Segawa et al. Segawa et al.'s failure to either expressly or inherently describe a gate stack having a non-crystalline structure bars an anticipation rejection of claims 23, 25, and 27 under 35 U.S.C. § 102(b). *See, Verdegaal Brothers v. Union Oil Co. of California*, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).

Likewise, Segawa et al. fails to describe a crystallized metallic silicide film "substantially devoid of silicon clusters" as recited in claims 24 and 28 of the present application. Although Segawa et al. disclose the crystallization of the metallic silicide film, Segawa et al. do not disclose a crystallized metallic silicide film wherein the silicon clusters necessarily formed during the annealing process are absent from the crystallized metallic silicide film. The Examiner indicates that Segawa et al. discloses a gate stack "wherein the metallic silicide is substantially devoid of silicon clusters." *See, Official Action*, page 3. However, support for this assertion is not found in Segawa et al. Unlike the present application, Segawa et al. fails to disclose "an ion implantation into the metallic silicide film...to amorphize the metallic silicide film" thereby dispersing any silicon clusters formed within the metallic silicide film during the crystallization process. This process, as disclosed in the present invention, substantially removes silicon clusters from a

crystallized metallic silicide film, thereby producing a "metallic silicide film substantially devoid of silicon clusters" as recited in claims 24 and 28. In addition, Segawa et al. does not disclose any alternate method of removing silicon clusters from the metallic silicide film. Because Segawa et al. fails to teach the removal of the silicon clusters which result from the crystallization of a metallic silicide film, Segawa et al. does not disclose a gate stack which is "substantially devoid of silicon clusters" as in the present invention. Therefore, the anticipation rejection under 35 U.S.C. § 102(b) of claims 24 and 28 is improper. *See, Verdegaal Brothers v. Union Oil Co. of California*, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987).

Furthermore, claim 26 recites a dielectric layer "substantially devoid of pitting." The pitting of a dielectric layer in a gate stack formation "is caused by the presence of the silicon clusters inside the metallic silicide film." *See, Specification*, page 5, lines 25-26. Because Segawa et al. fail to disclose a gate stack having a metallic silicide film substantially lacking silicon clusters, the gate stacks of Segawa et al. necessarily have pitted dielectric layers. The gate stack of the present invention, however, has either a non-crystallized metallic silicide film lacking silicon clusters, or a crystallized metallic silicide film wherein the presence of silicon clusters has been substantially eliminated by ion implantation prior to etching. Therefore, the gate stacks resulting from the teachings of the present invention have a dielectric layer which is "substantially devoid of pitting." Segawa et al.'s failure to disclose a gate stack having a dielectric layer "substantially devoid of pitting" precludes a rejection of claim 26 under 35 U.S.C. § 102(b). *See, Verdegaal Brothers v. Union Oil Co. of California*, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). Additionally, claims 27 and 28 depend from claim 26 which is not anticipated by Segawa et al., therefore claims 27 and 28 are allowable.

Because Segawa et al. does not disclose, either expressly or inherently, a gate stack having either a non-crystalline metallic silicide film, or a gate stack having a crystalline metallic silicide film substantially devoid of silicon clusters, claims 23-28 are not anticipated by Segawa et al. Applicants respectfully request the withdrawal of the anticipation rejection under 35 U.S.C. § 102(b) and the allowance of claims 23-28.

35 U.S.C. § 102(e) Anticipation Rejection

Anticipation Rejection Based on U.S. Patent No. 5,728,625 to Tung

Claims 23 through 28 stand rejected under 35 U.S.C. § 102(e) as being anticipated by Tung, U.S. Patent No. 5,728,625. Applicants respectfully traverse this rejection, as hereinafter set forth.

Applicants have deleted the terms “non-annealed” and “annealed” from claims 23-25, and 27-28, by the Amendments herein. Therefore, the Examiner’s objection to the terms “non-annealed” and “annealed” as non-limiting has been resolved by the amendments to the claims.

Tung discloses a process for fabricating a thin layer cobalt silicide device wherein cobalt silicide is annealed, thereby producing silicon clusters within the cobalt silicide layer. As noted previously, the present application teaches that “when a silicon rich metallic silicide is used, the annealing step causes the silicon within the metallic silicide to form clusters inside the crystalline structured metallic silicide film.” *See, Specification*, page 5, lines 13-15. Thus, the annealing steps of Tung as described in column 4, lines 52-56, column 7, lines 46-60, and column 8, lines 49-60, necessarily result in the formation of silicide clusters with the cobalt silicide film.

As taught by both the present invention and Segawa et al., crystallization of a metallic silicide occurs during annealing. Typically, an annealing step in which the temperature of the metallic silicide is raised above the temperature of 600° C results in the formation of silicon clusters within the metallic silicide. Claims 23, 25, and 27 of the present application each recite a gate stack formation wherein the metallic silicide is in a non-crystalline state. A non-crystalline gate stack such as is set forth in claims 23, 25, and 27 is not anticipated by Tung because Tung teaches an annealing step which necessarily crystallizes any metallic silicide films. Thus, any device formed using the teachings of Tung results in a crystalline metallic silicide which is different from the non-crystalline metallic silicide film of claims 23, 25, and 27 of the present invention. Claims 23, 25, and 27 are not anticipated under 35 U.S.C. § 102(e) because Tung fails to disclose either expressly or inherently a non-crystalline metallic silicide layer.

Although claims 24 and 28 of the present invention claim a crystalline metallic silicide, they include the further limitation of having a metallic silicide film “substantially devoid of

silicon clusters." Tung does not disclose a metallic silicide film substantially devoid of silicon clusters. The annealing steps of Tung result in the formation of silicon clusters within the cobalt silicide film of Tung as taught by both Segawa et al. and the present invention. Tung does not disclose a process by which such silicon clusters may be removed from the metallic silicide film. In contrast, the present invention discloses ion-implantation following an annealing of a metallic silicide film to dispose of silicon clusters which formed within the metallic silicide film during the annealing process. Tung's failure to teach the removal of silicon clusters from a metallic silicide film precludes an anticipation rejection of claims 24 and 28 under 35 U.S.C. § 102(e) because a metallic silicide film "substantially devoid of silicon clusters" as recited in claims 24 and 28 is only taught by the present invention.

Claim 26 of the present invention recites a gate stack on a dielectric layered semiconductor substrate wherein the dielectric layer is "substantially devoid of pitting." As taught in the present invention, the formation of silicon clusters in a metallic silicide film results in an increased etch rate which causes pitting within the dielectric layer. The absence of silicon clusters in the gate stack formations of the present invention results in an un-pitted dielectric layer as claimed in claim 26. The teachings of Tung do not disclose nor indicate that pitting within a dielectric layer may be prevented. Further, Tung fails to recognize, much less teach, why pitting may or may not occur, either expressly or inherently. Thus, Tung does not anticipate claim 26.

Claims 27 and 28 depend from claim 26, and are therefore patentable because they each depend from a non-anticipated independent claim. In addition, claim 27 includes the further limitation of a non-crystalline metallic silicide film which is not taught or suggested by Tung. In fact, the heat treatment step of Tung results in the formation of a device with a crystalline metallic silicide layer which is different from the gate stack claimed in claim 27. Likewise, a crystalline metallic silicide film substantially devoid of silicon clusters as claimed in claim 28 is neither taught nor suggested by Tung. Therefore, Tung fails to anticipate claims 27 and 28 of the present invention.

Because Tung does not disclose, either expressly or inherently, a gate stack having either a non-crystalline metallic silicide film, or a gate stack having a crystalline metallic silicide film

substantially devoid of silicon clusters, claims 23-28 are not anticipated by Tung. Applicants respectfully request the withdrawal of the anticipation rejection under 35 U.S.C. § 102(e) and the allowance of claims 23-28.

CONCLUSION

Claims 23 through 28 are believed to be in condition for allowance, and an early notice thereof is respectfully solicited. Should the Examiner determine that additional issues remain which might be resolved by a telephone conference, he is respectfully invited to contact Applicants' undersigned attorney.

Respectfully Submitted,



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